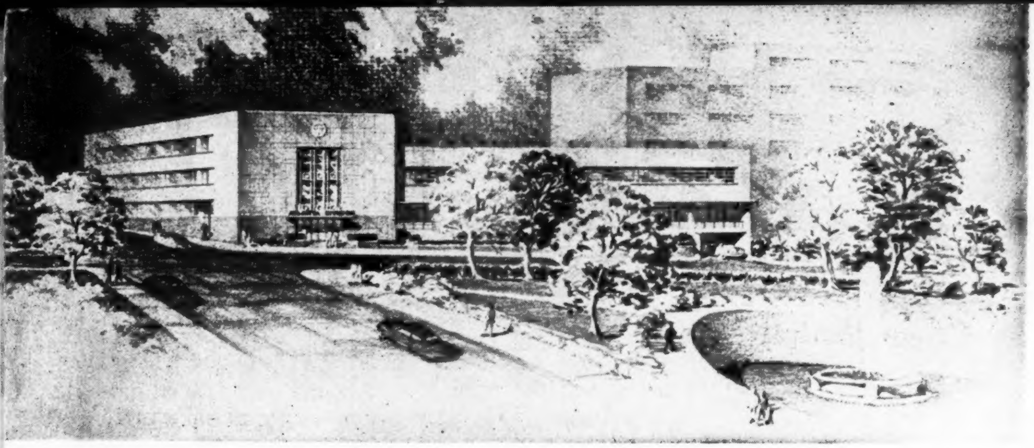

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THE DEVELOPMENT AND PRODUCTION OF RESOURCES

By

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In 100 years aluminum has risen from a position of virtually no importance as a resource to one of the world's most important metal resources. Approximately 100 years ago, in 1859, world production of aluminum is estimated to have been a little over two tons, just enough to load an average truck. In 1952 world production was over two and a quarter million tons, enough to load two tons in over a million average trucks.

In spite of this almost phenomenal growth in the importance of aluminum, apparently it is a resource that is to become even more important. For example, the President's Materials Policy Commission estimated that in the United States alone consumption of aluminum would increase from 1.143 million tons in 1952 to 4.5 million tons in 1975, which is almost twice the world's 1952 production. This estimate is, however, somewhat conservative as the following statement from the Commission's report indicates.

> We have chosen to project the 1975 United States demand for aluminum at 4.5 million (between 4 and 5 times the 1950 consumption) as indicating a plausible rate of growth. A figure much less than this would imply almost no incursions of aluminum into fields now held by other materials. A figure much greater, say 10 times the 1950 output, would be possible if aluminum were assumed to take over more than a small part of the functions now performed by wood and steel. The policy implications of a ten-fold increase should therefore be considered.[1]

This rise of aluminum from the status of a neutral material to that of a resource serves as one of the most outstanding illustrations of the fact that elements of the natural environment are not by nature resources but become resources. From a practical standpoint, virtually the only natural resources man has are the air he breathes and the space he occupies; all other resources were neutral stuff and became resources when man learned how to use them to satisfy his needs and wants. When man develops a function or functions for an element of the natural environment, that element becomes a resource; and the more functions he develops for an element, the more versatile and the more valuable a resource the element becomes. (The word "function" as used in this article is a technical term which very roughly translated simply means use. Without a use an element is not a resource but neutral material.)

Aluminum became a resource as a result of several technological discoveries which made it possible for society to (1) produce and (2) develop functions ("uses") for it. Among the first was one in 1825 when Hans Christian Oersted, a Danish chemist, succeeded in isolating aluminum. His process, though, was not economical and aluminum remained "neutral stuff." A few years later, two scientists, one French and one German, improved on Oersted's process so that by 1859 aluminum was selling for about $17 a pound. Seventeen dollars a pound, however, was still way above the current price of approximately 22¢ a pound which is principally responsible for aluminum having such an important role in our modern societies.

During the latter half of the nineteenth century, several additional developments combined to finally make possible the eventual production of low cost aluminum. These achievements improved the procedure followed in producing aluminum which involves two basic steps: one is the production of alumina or aluminum oxide from aluminum ore known as bauxite, and two, the extraction of pure aluminum from alumina. In 1889 a German chemist

We are happy to announce that the Division of Research was elected to membership in the Associated University Bureaus of Business and Economic Research at the association's annual meeting held in Washington, D. C., October 26-28.

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1 The President's Materials Policy Commission, **Resources For Freedom**, Volume II, United States Government Printing Office, Washington, D. C., 1952, p. 123.

developed an improved method for producing alumina and during the 1880's two other chemists, a Frenchman and an American, independently developed a method for using electricity to reduce aluminum from alumina. Solvay's invention for producing caustic soda also contributed significantly toward lowering the costs of producing alumina.

Dr. Eric W. Zimmermann summed up the work of these men which resulted in the low cost production of aluminum as follows:

> Together these men—Cowles, Bradley, Hall, Heroult, Bayer, Solvay, etc.—succeeded in laying the foundation for a commercial aluminum industry which in the course of half a century lifted this metal out of the class of curiosities and laboratory specimens into the class of industrial metals to which copper, lead, and zinc had belonged. In the late forties aluminum was selling in the United States for less than either of these three other metals. At the peak of the war effort probably more aluminum was produced than either lead or zinc.[2]

To complete the process of making aluminum a resource were the inventions which developed specific uses for the new low cost metal. One which has probably been as important a factor as any other is airplane construction. Another use now rapidly developing is in the construction industry. The construction of some recently erected buildings has been principally aluminum and glass. An older use familiar to most is in the manufacture of kitchen utensils.

All of these achievements, which in some 100 years transformed aluminum from a neutral material into a valuable metal resource, illustrate the nature of resource development and how neutral elements become resources. The whole process illustrates the basic principle that for an element to become a resource, that is to have a function, technology must be developed through which the element can be produced and used; society must be interested in using it, able to purchase it, and, where necessary, able to organize to produce and use it; and the cost must be equal to or less than the price that society is willing to pay for the resource. If these conditions are not met, an element is not a resource but is neutral material.

Once a society has developed a function or functions ("use or uses") for an element of the natural environment and it has hence become a resource, the next step is the development of a method to supply these functions. In the case of aluminum, once functions were developed, that is once conditions prevailed so that aluminum became a resource, the next step was the development of a method for supplying this resource to its respective functions.

This method for supplying a resource to its respective functions is the resource system which is the total behavior that a society adopts for making a resource available. It is, in a sense, a custom that is adopted by a society to provide a resource. Technically it is a society's institutional behavior for making any given resource available.

The American society, for example, has adopted a very definite customary method for making aluminum available to its various functions. One of the principal parts of the American economy's aluminum resource system is the aluminum industry, but the aluminum industry does not make up the entire aluminum resource system. The aluminum industry, it is true, does supply aluminum to aluminum functions but it is only a part of the aluminum resource system. It may, of course, be the major part of the system. A less apparent part of the aluminum resource system than the industry itself are the laws affecting the operation and structure of the industry—laws covering mineral rights, leasing practices, incorporation, labor organization, taxes, royalties, etc. Another less apparent part would be the attitudes toward aluminum ore production and export by the governments of those countries where much of this country's aluminum ore is mined.

A resource system has two aspects, physical processes and social processes. The physical processes refer to the technology involved. The physical process in an aluminum resource system would include mining, reducing, refining, transporting, storing, and manufacturing. The physical process

2 Zimmermann, Eric W., **World Resources and Industries**, Harper and Brothers, New York, 1951, p. 713.

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in an agricultural resource system such as cotton would include plowing, planting, weeding, poisoning insects, picking, ginning, transporting, weaving, sewing, storing, packing, and shipping. Sometimes the physical processes of two resource systems may partially coincide. For example, the physical processes for cotton and cotton seed resource systems to some extent coincide or are the same.

The social processes refer to the behavior and organization of *all* people who are involved in the system. The social process of a resource system includes how these people are organized, how the organizations operate, and the attitudes, beliefs, customs, traditions, folkways, and laws of these people. Are the people organized into large corporations, small companies, partnerships, or family clans? Do the people accept new ideas and changes rapidly? Are the people honest? What are the people's religious ideas and practices? Are the people's family and social customs conducive to industrialization or large scale organization? Are the people interested in improving their standard of living? What is the people's attitude toward those in their midst who differ politically, socially, religiously, economically, or physically? Are the people conservative or liberal in their economic and political attitudes? What are the people's social and working customs? What kind of authority do the people recognize?

The social process of a resource system might be classified into two phases. One would be that phase of a people's behavior which can be observed. It would include the customs, traditions, folkways, laws, mores, and organizations. The second part would be the attitudes, feelings, ideas, opinions, and viewpoints which cannot be seen but which determine the first part or the actual behavior of people.

The social processes of an aluminum resource system would include the attitudes, customs, traditions, feelings, folkways, mores, regulations, codes, and laws of the people who mine bauxite, those who transport it, those who process it into aluminum, and those who manufacture aluminum products. It would also include the organizations (and their operations) involved, such as organizations which mine, transport, and process bauxite, the manufacturing companies of aluminum products, labor organizations of which bauxite and aluminum workers might be members, and the many organizations involved in the distribution of aluminum.

An important point about the social processes of a resource system is that they do not necessarily have in them formal organizations. The social process of a water resource system might simply be made up of a set of laws, customs, traditions, and attitudes governing the behavior of people with regard to the raw material made available by the natural environment, and there may be no organizations directly involved in making the resource available. In most communities of any size, of course, an organization such as the city government usually provides water and so forms at least one organization in the resource system.

Primitive Resource Systems

The complexity of a resource system will depend upon the complexity and the variety of the operations of the system and the complexity of the function itself. In a primitive society one would expect the resource systems to be fairly simple because of the simple technology of the people and the simple functions which they may have developed for the elements of the natural environment.

The construction of homes in a primitive society might involve only clay, leaves, wooden poles, a few tools, and the labor of the members of the immediate family that will occupy the dwelling units. Since there are three materials involved in the construction of a house, there would be only three resource systems.

Each of these three resource systems can be thought of as an integrated group of activities whereby the material is made available at the point of construction. The operation of each system will be determined by the tools and technology used, and by the customs, laws, traditions, and attitudes of the people. Providing clay for the hut may be assigned by tribal custom to the women of the household. Custom in all probability will also indicate the particular manner in which the women will organize themselves to provide the clay. The oldest woman of the household or possibly the wife of the oldest man in the household may supervise the operation, the youngest may dig, and the remaining may haul the clay. Tribal law may assign to each household according to its social status in the community the particular clay deposit that must be used. The physical process of this system to provide clay may be nothing more than a crude tool for digging and a basket for carrying the clay to the site of the prospective building. In a similar manner the tools, technology, and tribal customs and laws will determine the organization of the resource systems for providing leaves and poles.

Whatever the technology of the tribe and whatever its customs, traditions, laws, and attitudes may be, each resource system will be an integrated pattern of human activity which will be structured within the framework set up by the technology, the laws, customs, attitudes, folkways, and traditions of the group. Any attempt to improve the efficiency of any one of the three systems will, therefore, require a change in one or more of these factors mentioned and many others.

It is important to note that quite possibly the efficiency of the system can be increased by making adjustments in the organization of the people in the system without a change in the tools or technology. A custom may make certain require-

SEPTEMBER
ATLANTA AREA ECONOMIC INDICATORS

ITEM	September 1955	August 1955	% Change	September 1954	% Change
EMPLOYMENT					
Job Insurance (Unemployment) Payments	$203,343	$233,718	−13.0	$359,531	−43.4
Job Insurance Claimants†	3,310	4,001	−17.3	5,103	−35.1
Total Non-Agricultural Employment	319,750	317,600*	+0.7	298,850	+7.0
Manufacturing Employment	90,100	89,100*	+1.1	78,650	+14.6
Average Weekly Earnings, Factory Workers	$68.61	$68.61*	0.0	$62.02	+10.6
Average Weekly Hours, Factory Workers	40.6	40.6*	0.0	39.5	+2.8
Number Help Wanted Ads	11,516	11,220	+2.6	7,296	+57.8
CONSTRUCTION					
Number Building Permits, City of Atlanta	868	1,044	−16.9	800	+8.5
Value Building Permits, City of Atlanta	$7,409,084	$10,833,409	−31.6	$7,315,218	+1.3
Employees in Contract Construction	21,100	21,650*	−2.5	17,300	+22.0
FINANCIAL					
Bank Debits (Millions)	$1,465.6	$1,546.8	−5.2	$1,296.0	+13.1
Total Deposits (Millions) (Last Wednesday)	$1,043.1	$1,047.3	−0.4	$978.4	+6.6
POSTAL§					
Postal Receipts	$1,475,002	$1,487,292	−0.8	$1,441,781	+2.3
Poundage 2nd Class Mail	1,439,524	1,277,119	+12.7	1,377,974	+4.5
OTHER					
Department Store Sales Index (Adjusted) (1947-49=100)	150	139	+7.9	131*	+14.5
Retail Food Price Index (1947-49=100)	111.1	110.6	+0.5	113.3	−1.9
Number Telephones in Service	266,292	263,880	+1.0	250,897	+6.1
Number Local Calls per Day	1,835,550	1,823,914	+0.6	1,710,434	+7.3

*Revised
§City of Atlanta only.
†Claimants include both the unemployed and those with job attachments, but working short hours.

Sources: All data on employment, unemployment, hours, and earnings: Employment Security Agency, Georgia Department of Labor; Number Help Wanted Ads: Atlanta Newspapers, Inc.; Building permits data: Office of the Building Inspector, Atlanta, Georgia; Financial data: Board of Governors, Federal Reserve System; Postal data: Atlanta Post Office; Retail Food Price Index: U. S. Department of Labor; Department Store Sales and Stocks Indexes: Federal Reserve Bank of Atlanta and Board of Governors, Federal Reserve System; Telephones in Service: Southern Bell Telephone and Telegraph Company.

JANUARY THROUGH SEPTEMBER, 1954 and 1955

1955	1954	ITEM	% CHANGE
86,713	59,969	Number Help Wanted Ads	+44.6
19,383	15,222	No. Construction Employees*	+27.3
N.A.	N.A.	Department Store Sales, Based on Dollar Amounts**	+15.0
N.A.	N.A.	Department Store Stocks**	+14.0
$12,667.4	$11,287.9	Bank Debits (Millions)	+12.2
86,222	78,111	No. Manufacturing Employees*	+10.4
8,486	7,698	Number Building Permits, City of Atlanta	+10.2
$67.36	$62.50	Average Weekly Earnings, Factory Workers*	+7.8
12,462,041	11,581,073	Poundage 2nd Class Mail, Atlanta Post Office	+7.6
$1,043.1	$978.4	Total Deposits (Millions)**	+6.6
266,292	250,897	Telephones in Service**	+6.1
310,439	295,672	Total Non-Agricultural Employment*	+5.0
$12,815,118	$12,373,480	Postal Receipts, Atlanta Post Office	+3.6
40.6	39.7	Average Weekly Hours, Factory Workers*	+2.3
111.1	113.3	Retail Food Price Index (Sept.)	−1.9
$66,149,765	$68,318,176†	Value Building Permits, City of Atlanta	−3.2
38,846	51,429	Job Insurance Claimants	−24.5

†Special ruling permitted construction of $20,500,000 Grady Hospital addition without permit. If included, total above is $88,818,176, and the change becomes minus 25.5%.
*Average Month
**End of Period
N.A.—Not Available
Sources: Same as Page 4

ments that inhibit the efficiency of the system. Traditions may allow some members to work less than others and hence increase the total time necessary to provide the material needed for the construction of the house. Another custom may prevent the members of some household, because of their status in the tribe, from procuring raw materials from the nearest or most convenient sites. In fact, custom and tradition may make a resource system in a primitive society very complex even though the technology is simple.

Modern Resource Systems

In an industrial society such as that of the United States, although resource systems are much more complex, the basic principles mentioned above continue to prevail. The structure and operation of each resource system like those in a primitive society will depend upon tools, technology, laws, customs, traditions, mores, attitudes, sentiments, and feelings. To improve efficiency, one or more of these must be changed or altered.

Resource systems in industrial societies become very complicated because of advanced technology and organization, the wide variety of social, political, and economic organizations found, and the wide range of customs, traditions, attitudes, etc., prevailing. Systems in an industrial society will also become complicated because of their international aspects. A resource system may operate in several countries which will involve it in different customs and different legal systems.

The aluminum resource system to provide aluminum for the United States is an example of the very complicated resource system. Part of the system operates in foreign countries where bauxite is mined to be shipped to the United States. As a result the aluminum resource system is subject to the laws, customs, traditions, etc. of the people in these areas where bauxite is extracted from the ground. Sometimes these customs and laws can seriously impair the efficiency of bauxite and increase its costs. Laws, for example, affect the taxes paid by the resource system to the local government, payments for mineral leases, and wages paid to employees. Customs will also affect personnel-management relations.[3] Once in the United States, the aluminum resource system will also be found operating throughout the country under various customs, laws, traditions, organizations, etc.

A resource system, such as that of aluminum, in an industrial economy might be thought of as having subordinate parts which supply specific functions. The principal role of the aluminum resource system is to supply aluminum ingots but the subordinate parts furnish the final products designed to supply specific functions.

Nature of Resource Systems

The availability of a resource to a society is determined by the operation of the resource system, and the operation of the resource system is determined by the structure of the system. The structure of the resource system is in turn determined by the natural environment, and the attitudes, customs, laws, mores, feelings, organizations, technology, and equipment involved. Expressed more technically, the structure of a resource system is determined by the natural environment, the ethos, manifestation of the ethos, social organizations, knowledge and artifacts.

It then follows that to increase resource availability, one or more of these factors determining the structure of the system must be changed or adjusted because once a system is created the structure will remain the same as long as these factors determining its structure and their relationship with one another remain the same. Once a system is structured for the production of cotton, this system will remain the same if there is no change in such items as the soil, the climate, the physical characteristics of the people, people's attitudes, feelings, customs, traditions, etc., organizations, level of knowledge, and equipment. Naturally such a static situation can hardly prevail. Changes are always taking place but some will have almost imperceptible effects while others may produce very drastic changes. The important point is the type and rate of change.

The structure and operation of the aluminum resource system of the United States could be changed by a new law affecting mineral rights, labor organization, corporate taxes, or royalty payments or by a new technology for extracting aluminum from bauxite. A very recent and significant change in the aluminum resource system was the breaking up a few years ago of the monopoly held by the Aluminum Corporation of America when Kaiser and Reynolds began producing aluminum.

The structure of any particular resource system will tend to vary throughout a society as the characteristics of the various factors structuring the system change. Water resource systems in the United States vary greatly because of the difference in the availability of water and in water laws. The electric power resource system in the United States varies considerably. In some areas power is produced by coal, other areas by gas, and others by water. When atomic energy is used in the production of electric power, some very significant changes can be expected in the power resource system. The cotton resource system differs greatly between various sections of the United States with variation in the types of organizations used for planting and harvesting it.

3 It might be noted that the aluminum resource system which is producing aluminum in a primitive society for shipment to an industrial society does not necessarily constitute part of the aluminum resource system in that society, especially if the society does not use aluminum. If the society does not use aluminum, the aluminum resource system simply operates in the society but does not provide aluminum to the society because it has no need for it since aluminum is not a resource of that society. The operations of the aluminum resource system, however, may be a part of that society's resource system to provide cotton which must be imported. Under these circumstances aluminum would be a resource with which to trade but would not have any other use.

The various resource systems that develop for making resources available become a part of the culture of a society just as customs, traditions, languages, and laws become a part of the culture, and these resource systems are passed on from generation to generation; and like customs, traditions, etc., resource systems will determine to a great extent the behavior of the people who become a part of them. Individuals who become a part of the system through employment by an organization in the system or by themselves starting an organization within the system will have their behavior to a great extent affected by the system. To what extent their activities will be affected by the system will depend upon the nature of the system. Some systems will tend to mold the individual more than others. This molding of the individual by the system will happen because the system will encourage individuals to direct their efforts within the pathways of the system. Since these will be the lines of least resistance, they will tend to discourage other human behavior whether valuable or not.

It is probably this relationship between systems and individuals within the systems that has given rise to the expression which runs something as follows: "It is not the individual but the system." There is in this expression considerable truth, for, unless an individual is able to adjust himself to the system in which he is working, he will have great difficulty functioning in the system and may well be ineffective.

What has just been said is not necessarily intended to deny the individuality of members within the group but merely to point out that the individuality is restricted—far more than most people realize. An individual's behavior is to a great extent molded by the culture in which he is born and brought up. In a similar manner an individual working in a resource system may find his behavior molded. Most systems do tolerate some individuality, but only within limits.

The tendency of systems to channel or direct human development is explained by the need that a system has to develop elements within it which will preserve it. These are usually considered conservative elements and certainly a system needs such elements which seek to preserve the status quo and to maintain the system. At the same time, however, if the elements which seek to preserve the status quo are too strong, there will be a tendency for the system to be solidified and to lose flexibility of operation.

Analysis of Resource Systems

This paper has placed great emphasis on the idea that resource systems are an integrated activity of human behavior designed to supply resources to functions which a society has developed. One of the principal purposes behind this is simply to stress as much as possible the idea that a resource system is an integrated activity which embodies the attitudes, customs, mores, traditions, organizations, etc., adopted by a society in making resources available.

In most cases the process of analyzing resource availability tends to emphasize the physical or technical aspects and sometimes to completely ignore the social processes. This, it is suggested, is a critical error for often the social processes are the principal factors affecting the availability of resources.

An outstanding example of this problem is the fact that although technology for producing and using elements of the natural environment has advanced rapidly and is continuing to advance, many of the world's societies are not able to take advantage of the technology even though they may have the necessary raw materials. The underlying problem of resource availability in the world today is not so much one of new technology but one of changing patterns of human organization to make the resource available.

The lack of human organization in some of the world's societies for making use of technology can be seen in two ways: one is the failure of some societies to make use of raw materials located in their territories and two, as a result of this default, is the production of these raw materials in the underdeveloped areas and their shipment to more advanced countries for use there.

Even in an advanced country like the United States the efficiency of resource systems could be increased through improving the social processes so as to make full use of technology. Such changes in social process would, of course, involve changes in organization, laws, attitudes, customs, traditions, folkways, and mores.

The full analysis of a resource system can be a very formidable activity.[4] The approach to studying a system would logically begin with an analysis of the individual resource in terms of the influences which have made it a resource. Earlier in this paper the factors making aluminum a resource were reviewed. A material becomes a resource when it has a function or functions in a society and so a detailed analysis should be made of these functions.

Following an analysis of the resource itself would be a description and analysis of the resource system which makes the resource available to its function or functions in society. This would include a description and analysis of the natural environment involved and of the attitudes, feelings, views, traditions, customs, laws, folkways, knowledge, technology, organizations, and equipment involved and how these various factors interact with each other in the system. The nature of the system will serve as a guide to deciding where the emphasis

4 The author and a colleague recently completed a pilot study in which an attempt was made to develop some techniques for analyzing a resource system. The study was made of the Alabama Power Company. The Bureau of Business Research at the University of Alabama is preparing to publish this study.

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should be placed in analyzing the factors which have molded the system. Examples of some of the questions to answer in analyzing a system would be: What laws affect the system and how? What governmental organizations affect the system and how? What are people's customs and what affect do they have? What are the basic attitudes of the people in the system who have responsible or influential positions? What are the political relationships of the system? Does the general structure of the system accept new ideas in technology and in organization? How does the system affect the individual personalities? What kind of people does the system promote? How does communication take place in the system?

Because of the number of fields involved in analyzing the forces which have structured a resource system the most effective way to make an analysis probably should be through a team of specialists, because seldom will any one individual be fully qualified to analyze all of the forces molding a system notwithstanding how competent the individual may be in his own field. Such a team should be made up of specialists in the natural sciences, the social sciences, and people in the various occupations such as law, medicine, government, or business. The makeup of the team, of course, would be based on the resource under consideration. A possible approach to organizing a study under such a procedure as is here suggested would be to organize an executive committee to supervise the study and as various problems are discussed to call upon specialists for their assistance.

Among the basic questions to be asked in the process of studying a resource system are (1) what is the hierarchy of values influencing the structure of the system, (2) how rationally are these values being achieved, (3) what is the role of knowledge in the system, and (4) what is the role of people and what happens to them in the system.

The dominant feature of any resource system will be the hierarchy of values affecting the structure of the system and how rationally these values are being achieved. The hierarchy of values will include those of the culture as a whole as they affect the system and of the people within the system itself. The rationality in reaching the goal determined by the hierarchy of values and the use of knowledge will be the key to the system and should help evaluate any measures which may be considered for increasing the productivity of the system. In a similar fashion increasing the general resource development of the system will center around an understanding of the hierarchy of values and the role of knowledge in achieving them.

The ultimate goal of analyzing a resource system should be to insure an adequate and dependable flow of materials at the lowest cost consistent with the values of the society to supply the functions which society has created for that resource.

A basic hypothesis suggested here is that the ability of a people to increase their resources will be determined by the basic characteristic of their ethos. A people's resources will increase as they develop a scientific, objective, and pragmatic attitude toward the development and use of knowledge and toward change; as they develop a desire to increase knowledge, resource development, and use; and as they are able to develop a society in which the individual members will feel themselves secure yet free to develop into creative and expressive personalities. Failure to incorporate the abilities of all groups and individuals to the fullest will inhibit resource development and prevent a people from reaching the highest possible standard of living within their existing state of technological development.